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## A SYNOPSIS OF CHARACTERS OF SOME FISHES BELONGING TO THE ORDER HAPLOMI.

EDWIN CHAPIN STARKS.

The orders Haplomi and Iniomi are distinguished from the Nemotognathi (the cat fishes) and the Plectospondyli (the minnows and suckers) by having normal anterior vertebræ; from the Isospondyli (the herring and trout-like fishes) by the absence of a mesocoracoid; from the several orders of eel-like fishes, by the comparatively few vertebræ, the presence of ventral fins, and the unrestricted gill openings; from several peculiar small orders by apparently sufficient characters, but which for present purposes need not be considered.

Thus these orders seem to be made up of soft-rayed fishes, which are thrown together because they lack the distinguishing characters of other groups, rather than because they have such characters of their own. This condition naturally would tend to bring together forms that are not very closely related.

The families of the Haplomi have either widely diverged from each other or are not of the same line of descent. The order is not held together by any important character, though some very peculiar characters may be used to rather widely separate three groups.

I have not studied the Iniomi,<sup>1</sup> but from the definition given below I find it impossible to separate the Haplomi from it. The free condition of the scapular arch has been the most useful character in separating these two orders, but as this condition is found in the families Esocidæ and Umbridæ, it cannot be used unless we transfer these families from the latter order to the former. Obviously this is not advisable as *Umbra*, especially, is certainly nearer the family Pœciliidæ than it is to any family in the order Iniomi.

The Iniomi was established by Dr. Gill<sup>2</sup> to include those forms

<sup>1</sup> Except to determine that the condition of the attachment of the scapular arch to the cranium is the same in *Synodus* as it is in *Esox* and *Umbra*.

<sup>2</sup> Proceedings of the U. S. National Museum, 1884, p. 350.

in which the scapular arches are "connected with and impinge on the occiput behind and on each other, and are otherwise free from the cranium." In his original definition he calls Iniomi a group, and later in his "Families and Subfamilies of Fishes" <sup>1</sup> he treats it as a superfamily. Jordan and Evermann in "Fishes of North and Middle America" raise it to ordinal rank, and point out that the absence of the mesocoracoid is the most important character by which the Iniomi are separated from the Isospondyli.

A readjustment of the orders Haplomi and Iniomi will be necessary, and either a separation based on characters unstudied and unconsidered, or a merging of one into the other will result. This will necessitate a study of many more forms than are here considered.

The knowledge of the following characters I obtained in studying the relationships of *Dallia pectoralis*. As I am not at this time ready to take up an extensive investigation of the orders Haplomi and Iniomi it seems better, while it is fresh in my mind, to publish this material in the following form as a working basis, rather than to hold it indefinitely in abeyance.

### Order HAPLOMI.

Soft rayed fishes without a mesocoracoid and with the anterior vertebræ normal. Parietals separated by the supraoccipital. Alisphenoids not meeting in a median line in front of brain case. Exoccipitals separated by basioccipital. Postclavicle composed of a single element. Actinosts four. Opercular bones all present. Ventral fins abdominal, each attached to a simple flat pelvic bone. Pectoral fins placed low. Dorsal fin placed more or less posteriorly. Air bladder with a distinct pneumatic duct.

### Superfamily Esocoidea.

Ethmoid represented by paired elongate dermal bones; metapterygoid present, forming the upper margin of the cheek bones above the symplectic; symplectic normal; palatine and pterygoid both present and normal; the former with teeth; primaxillaries

<sup>1</sup> Sixth Memoir, National Academy of Sciences, Vol. VI.

without backward extending processes on median line of snout ; maxillaries forming lateral margin of mouth ; two toothed and two toothless superior pharyngeals present on each side ; post-temporal connected to the epiotic by a ligament ;<sup>1</sup> nearly meeting its opposite fellow just behind the occipital region ; supra-clavicle normal in size ; post-clavicle a single ray of bone ; hypercoracoid foramen only notching the lower edge of hypercoracoid ;<sup>2</sup> actinosts rather elongate, all ending against hypercoracoid or in cartilage opposite that bone ; pelvic bones without an overlapping spur ; upper end of shoulder girdle attached by ligament to first vertebra ; parapophyses normally developed only posteriorly ; the hæmal spines which support caudal attached by suture to their centra ; posterior vertebræ with a very decided upward bend ;<sup>3</sup> vent normal in position.

#### Family ESOCIDÆ.

Characters as indicated by *Esox reticulatus*.

Cranium long and slender, with a narrow projecting rostrum ; interorbital septum single ; myodome short not opening posteriorly ; the prootic shelf above not nearly reaching to mouth of anterior opening to brain case ; parietals extending over a deep cavern to pterotic ; suborbital present ; a lateral wing extending upward from parasphenoid barely reaching to alisphenoid ; septomaxillaries<sup>4</sup> present between ethmoid and vomer ; vomer large, reaching anterior to parasphenoid ; nasals present ; basisphenoid extending upward from parasphenoid, Y-shaped and unattached above ; opisthotic absent ; palatine joined to prefrontal by a slender process ; anteriorly without a process hooking over maxillary ; a wide open space between the hyomandibular and the preopercle opposite the middle of the latter ; premaxillaries widely separated from each other by the rostrum ; maxillary with a

<sup>1</sup> In a specimen of *Esox* 40 cm. in length the ligament is 4 mm. long. In *Umbra* it is comparatively as long.

<sup>2</sup> See exception under description of Esocidæ.

<sup>3</sup> In *Esox* the narrow hypural plate is placed at an angle of about 45 degrees, and the hæmal spine from the preceding vertebra runs horizontally back to the base of the middle caudal rays.

<sup>4</sup> E. P. Allis, Jr., discusses the septomaxillaries and the paired ethmoid of *Esox*, in a paper entitled "On Certain of the Bones of the Cheek and Snout of *Amia calva*," *Jour. of Morph.*, Vol. XIV., No. 3, 1898.

large supplemental bone ; a large preorbital and four suborbitals present ; posttemporal a wide plate bent longitudinally at a right angle ; its posterior edge concave, not typically forked ; its lower limb connected by ligament to exoccipital ; a broad ribbon of connective tissue connecting the inner surface of the supraclavicle with the first vertebra ; <sup>1</sup> hypercoracoid simply notched by its foramen, which opens against cartilage between the coracoid elements ; <sup>2</sup> lower pharyngeals elongate, not in contact at their inner edges ; an ankylosed epipleural on each of the two first vertebræ ; vertebræ number  $36 + 17 = 53$  ; all abdominal neural processes attached by suture ; parapophyses developed as processes only posteriorly.<sup>3</sup>

### Family UMBRIDÆ.

Characters as indicated by *Umbra lima*.

Cranium short and normal in shape ; interorbital septum double, with the sides widely separated throughout ; no myodome ; parietal separated from pterotic by an area of cartilage ; supraorbital absent ; parasphenoid not sending a lateral wing up to alisphenoid ; vomer very small, scarcely larger than its patch of three or four teeth ; loosely attached to the surface of the parasphenoid, and nowhere reaching to the edge of that bone ; no septomaxillaries or nasals present ; a preorbital but no suborbitals present ; <sup>1</sup> basisphenoid absent ; a very small loosely attached opisthotic present in usual position ; <sup>2</sup> palatine with a process hooking over the maxillary ; no open space between

<sup>1</sup> The connecting band does not appear to be of the same compact ligamentous nature as in *Umbra*, but is composed of more loosely connected fibers. It does not join the tip of a lateral process, but is attached directly to the side of the vertebra.

<sup>2</sup> In a specimen examined of *Esox lucius*, about the same size as the above (40 cm. in length) the foramen is entirely contained by the hypercoracoid.

<sup>3</sup> The parapophyses are represented by small ossicles attached to the centra by suture, and set in sockets so that the ribs appear to be attached directly to the vertebræ until careful examination is made. They first appear on the third vertebra, but are little developed in front of the ninth or tenth. Posterior to the twenty-eighth they develop outward and downward as small processes in front of the base of each rib. Posteriorly they grow longer and the last two or three are ankylosed to the centra.

<sup>4</sup> The sensory tunnel which is usually continued from the frontals by the nasals, opens to the exterior as soon as it leaves the former bone and extends no further forward.

<sup>5</sup> It is easily pulled away with the posttemporal, remaining attached to the lower ligament of that bone.

the preopercle and the hyomandibular; premaxillaries meeting at the median line on snout as usual; no supplemental maxillary bone; lower limb of posttemporal represented by a short triangular process from which a ligament runs to the opisthotic;<sup>1</sup> a strong ligament extends from a lateral process on the first vertebra to the inner surface of the supraclavicle;<sup>2</sup> the hypercoracoid foramen is a notch in the hypercoracoid open against the hypocoracoid; lower pharyngeals in contact along their inner edges; vertebræ number  $21 + 14 = 35$ ; epipleurals of first vertebrae not ankylosed; all neural processes ankylosed to vertebral centra; no parapophyses developed except on last four abdominal vertebrae;<sup>3</sup> ribs fitting into depressions with slightly raised edges on the body of the vertebrae; the first vertebra carries no rib.

### Superfamily Pœciloidea.

Ethmoid represented by a single nearly circular scale of bone; metapterygoid absent; the symplectic forming the upper margin of the cheek bones behind the mesopterygoid; symplectic very large, sending a long slender process behind the quadrate nearly to the condyle of the mandible; palatine-ptyergoid arch reduced to a single element, and without teeth;<sup>4</sup> premaxillaries each with a small backward extending process on median line of snout; premaxillaries forming lateral margin of mouth; superior pharyngeals either three toothed patches, or ankylosed into a single one on each side; the usual toothless one of first arch either present or absent in the former condition, but that of second arch never toothless; posttemporal directly attached to epiotic without the intervention of a ligament; supraclavicle a very small scale of bone, scarcely sufficient to separate the posttem-

<sup>1</sup> Four specimens have been examined and no indication found towards ossification of this ligament as in *Dallia*.

<sup>2</sup> This ligament is probably the homolog of the ray of bone in *Dallia pectoralis* that is in the same position.

<sup>3</sup> The process on the first vertebra to which the supraclavicle ligament is attached may possibly be considered a parapophysis also.

<sup>4</sup> The posterior end of the palatine-ptyergoid element borders the upper anterior edge of the quadrate, and is braced above by the mesopterygoid, as is usual for the ptyergoid; the anterior end is attached to the prefrontal and maxillary, as is usual for the palatine; making it appear probable that these two elements have ankylosed.

poral from the clavicle; postclavicle a simple ovate scale of bone; hypercoracoid foramen entirely enclosed by the hypercoracoid; actinosts small, deeper than long, no opening between them, two on each the hypercoracoid and the hypocoracoid; pelvic bones each with a spur extending inward, one of which overlies the other; upper end of shoulder girdle joined to basioccipital by a long ligament;<sup>1</sup> large projecting parapophyses present on all abdominal vertebræ; the caudal supporting hæmal spines ankylosed to their centra; the posterior vertebræ not tilted up; vent normal in position.

## FAMILY PÆCILIIDÆ.

### Subfamily FUNDULINÆ.

Characters as indicated by *Fundulus similis*.<sup>1</sup>

Interorbital septum double, its sides widely separated throughout; no myodome; parasphenoid sending a lateral process up to alisphenoid; supraoccipital expanded latterly on top in a thin horizontal wing; epiotic developed backward in a long thin process as in the genus *Mugil*; occipital condyle partly formed by exoccipitals; prefrontals not meeting at the median line; basi-sphenoid and opisthotic absent; mandible normal; premaxillaries normally curved; posttemporal a simple bone with no indication of a lower fork, normally attached to epiotic; three superior pharyngeals on each side joined (not ankylosed) to form an ovate plate, covered with molar-like teeth near middle of bone, which change to small blunt conical teeth near outer edges; lower pharyngeals joined to each other by deeply dentate and interlocked suture,<sup>3</sup> together forming a triangular bone with concave

<sup>1</sup> The ligament runs from the middle of the outer edge of the basioccipital to the upper end of the clavicle in *Pæcilia* and *Cyprinodon*, equally to the inner surface of the supraclavicle and the posttemporal in *Fundulus*.

<sup>2</sup> *Gambusia* (as exhibited in species *nobilis*) agrees with *Fundulus* in character of superior pharyngeals and unforked posttemporal but in the condition of the occipital condyle resembles *Pæcilia*.

<sup>3</sup> The lower pharyngeals of the following species of *Fundulus* have been examined: *siminolis*, *catenatus*, *majalis*, *stellifer*, *diaphanus*, *nottii*, *notatus*, *sciadicus*, *rathbuni*, *zebrinus* and *heteroclitus*, and a nearly uniform gradation found from the first, where the pharyngeals were joined by simple suture, together forming a triangular plate, to the last, where they were elongate and attached only at their anterior ends, diverging posteriorly. They were all joined more or less loosely. None were attached by dentate suture, as in *similis*. The gradation from one to another was in about in the order here given.

sides, covered with teeth similar to those above; interhyal present; urohyal laterally expanded, broader than high; parapophyses present on all abdominal vertebræ, the posterior ones the largest, much smaller than in *Pæcilia*, but otherwise similar.

#### Subfamily CYPRINODONTINÆ.

Characters as indicated by *Cyprinodon carpio*.

Interorbital septum single; a short wide myodome developed; parasphenoid not sending a lateral process up to alisphenoid; supraoccipital crest normal; occipital condyle partly formed by exoccipitals; prefrontals meeting at the median line; a small basisphenoid extending upward from the parasphenoid, its upper end unattached; opisthotic absent; mandible and premaxillaries normal; posttemporal widely forked, its upper limb normally joined to epiotic, its lower limb to exoccipital at some distance from the opisthotic region,<sup>1</sup> without the intervention of a ligament; superior pharyngeals as in *Fundulus*, the teeth sharper, none of them molar; lower pharyngeals loosely joined to each other, together forming a triangular-shaped bone; interhyal present; urohyal normal; parapophyses as in *Fundulus*.

#### Subfamily PÆCILINÆ.

Characters as indicated by *Pæcilia elongata*.

Interorbital septum double, the sides widely separated throughout; no myodome; parasphenoid sending a lateral process up to alisphenoid; supraoccipital crest expanded laterally on top in a thin horizontal wing; epiotics not produced backwards; occipital condyle confined to basioccipital; prefrontals not meeting at the median line; basisphenoid absent; a small opisthotic present; mandible reduced in size, its elements of complex shape, and loosely connected; side of maxillary turning at a sharp angle with the front; posttemporal forked, the upper limb firmly attached to the cranium, lying closely against the oblique upper surface of the epiotic for nearly its whole length, and leaving scarcely any space between its base and the skull; the lower fork attached directly to the opisthotic without the intervention

<sup>1</sup> The opisthotic when present in other species covers the suture between the exoccipital and the pterotic.



of a ligament ; superior pharyngeals ankylosed into a single elongate bone on each side, and covered with about sixty rows of very fine close set bristle-like teeth, which grow larger posteriorly ; lower pharyngeals large, joined along their entire inner edge (not ankylosed) to form a single concave surface, curved to coincide with the convex superior pharyngeals, covered with teeth similar to those above, but longer and more bristle-like anteriorly ; interhyal absent ; other hyoid bones normal ; very large parapophyses present on all abdominal vertebræ, growing larger to the fourth pair, thence smaller posteriorly ; none of them transversely connected ; the ribs attached to their tips.

### Superfamily Amblyopsoidea.

Ethmoid an unpaired median bone ; metapterygoid present above a normal symplectic ; palatine and pterygoid both present ; the former with teeth ; premaxillaries with small backward extending processes ; three tooth bearing superior pharyngeals present on each side ; posttemporal forked and normally attached to cranium, the upper limb directly to epiotic, the lower by a short ligament to the opisthotic ; supraclavicle well developed ; post-clavicle absent ; hypercoracoid entirely containing its foramen ; actinosts as in the Pœciliidæ ; upper end of clavicle attached to first vertebra by a ligament ; pelvic girdle composed of two small simple rays tapering forward and apparently not in contact with each other ; ventral fins sometimes absent ; parapophyses present on all abdominal vertebræ ; the caudal supporting hæmal spines ankylosed to their centra ; posterior vertebræ not tilted up ; vent close behind isthmus.

### Family AMBLYOPSIDÆ.

Characters as indicated by *Amblyopsis spelæus*.

Interorbital septum double, the sides widely separated ; no myodome ; no lateral process from parasphenoid to alisphenoid, but the latter developed downward to the side of the former largely enclosing the side of the cranium anterior to the prootic ; no supraoccipital crest developed ; occipital condyle partly formed by the exoccipitals, which are widely separated by the basioccipital ; opisthotic well developed ; parasphenoid very wide, ante-

riorly bending up at the sides and leaving only a very small space between it and the frontal ; three tooth bearing superior pharyngeals present on each side ; not connected to form a single patch ; the first very small, the last two very much larger and equal in size ; lower pharyngeals loosely in contact at the median line ; the last basibranchial bearing teeth similar to those on the lower pharyngeals ; hyoid bones all present and normal ; vertebræ number  $14 + 16 = 30$  ; neural and hæmal spines all ankylosed to the vertebral centra ; the spines of only two vertebræ anterior to the hypural assist in supporting the caudal.

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